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Phase-averaged analysis of an oscillating water column wave energy converter

Alan Fleming, BEng (Hons)

National Centre for Maritime Engineering and Hydrodynamics

Australian Maritime College

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DECLARATIONS

AUTHORITY OF ACCESS

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STATEMENT OF ORIGINALITY

This thesis contains no material that has been accepted for a degree or diploma by the University or other institution. To the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due acknowledgement is made in the text.

Signed: _____

Alan Fleming

Date:_____

STATEMENT OF CO-AUTHORSHIP

Chapters 2-4 of this thesis have been prepared as scientific papers. In all cases experimental design, experimentation, data analysis and interpretation, and manuscript preparation were the primary responsibility of the candidate. However work was performed in collaboration with supervisors and co-authors. Details of contributions are outlined below:

Chapter 2 (paper 1)

(Phase-averaged flow analysis in an oscillating water column wave energy converter)

Laurie Goldsworthy provided technical knowledge and support in PIV experimental setup, acquisition and post-processing. Gregor Macfarlane provided testing facility support and manuscript preparation assistance. Tom Denniss provided intellectual property. Irene Penesis and Neil Bose contributed to data interpretation and manuscript preparation.

[Candidate 82%, Penesis 4%, Goldsworthy 4%, Macfarlane 4%, Bose 4%, Denniss 2%]

Chapter 3 (paper 2)

(Phase-averaging of velocity fields in an oscillating water column using splines)

Irene Penesis, Gregor Macfarlane and Neil Bose contributed to manuscript preparation and phase-averaging algorithm design. Scott Hunter provided intellectual property.

[Candidate 83%, Penesis 5%, Macfarlane 5%, Bose 5%, Hunter 2%]

Chapter 4 (paper 3)

(Energy balance analysis for an oscillating water column)

Irene Penesis, Gregor Macfarlane and Neil Bose contributed to manuscript preparation and conducted extensive discussions on the energy balance. Tom Denniss contributed intellectual property and valuable feedback.

[Candidate 85%, Penesis 5%, Macfarlane 5%, Bose 3%, Denniss 2%]

We the undersigned agree with the above stated "proportion of work undertaken" for each of the above published (or submitted) peer-reviewed manuscripts contributing to this thesis:

Signed: _____ _____

Dr Irene Penesis	Assoc. Prof. Giles Thomas
Supervisor	Acting Director
National Centre for Maritime Engineering and Hydrodynamics	National Centre for Maritime Engineering and Hydrodynamics
University of Tasmania	University of Tasmania

Date:_____

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ABSTRACT

The work described in this thesis is concerned with the application of phase-averaging to experimental data obtained for a forward-facing bent-duct oscillating water column (OWC) wave energy converter. Experiments were performed on a three-dimensional model of the OWC in monochromatic waves. The research includes the development of new curve-fitting and ensemble-averaging phase-averaging algorithms designed to phase-average two-dimensional particle-imaging velocimetry (PIV) data. The phase-averaged PIV velocity fields were then used for qualitative and quantitative analysis. Qualitatively - visualisation of the velocity fields as vectors over a wave cycle shows the average flow field phenomena including bulk flow, water column slosh, front wall swash and downwash, vortices and an outflow jet. Quantitatively – two-dimensional kinetic energy and vorticity was calculated from the phase-averaged velocity fields and used in an energy balance analysis.

Experimental and theoretical data were combined in an energy balance analysis of the OWC to map the flow of energy from the incoming waves to intermediate stores and finally to sinks, which importantly permits the inclusion of non-linear phenomena. Using the energy model it was found that for the OWC model tested that the phase-averaged energy dissipated by the power-take-off was greater during water outflow than during water inflow. Phase-averaged experimental analysis of OWCs is an additional tool suitable for the design of underwater geometry of OWCs with potential application to other wave energy converters.

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